

AMENDMENTS TO THE SPECIFICATION

Please amend the following paragraphs as follows:

Page 1, line 1 to page 4, line 18:

METHOD OF FORMING GATES IN SEMICONDUCTOR DEVICES

BACKGROUND OF THE INVENTION

Technical Field of the Invention

~~The present invention relates to a~~ A method of forming the a gate in the a semiconductor device, ~~and more particularly, to the method of forming the gate in the semiconductor device,~~ is disclosed which can prevent abnormal oxidization and lifting at ~~the~~ an interface of the stack gate which comprises ~~consisting of~~ polysilicon and a metal, ~~and~~ The disclosed method can be applied to even the single metal gate, by replacing a re-oxidization process for ~~recovering~~ reducing damage ~~of~~ to the gate oxide film generated ~~in~~ during the gate patterning process with ~~the~~ an oxygen plasma treatment.

Background of the Related Art

In the conventional process of forming the a gate electrode using the a polysilicon film, the a re-oxidization process ~~was~~ is performed for the purpose of ~~recovering~~ reducing micro-trench ~~and~~ damage occurring in the gate oxide film when the polysilicon film is etched and for increasing the device reliability by oxidizing the electrode material remaining in the semiconductor substrate and increasing the thickness of the gate oxide film at the gate edge. It is ~~inevitable~~ important to perform the re-oxidization process since the thickness and film

quality of the gate oxide film at the gate edge significantly influences hot carrier properties, sub-threshold properties (off-leakage, GIDL, etc.), punch-through properties, the operation speed of the device, reliability, and the like.

In recent years, in order to lower the resistance of the gate, the polysilicon film and the metal film are stacked to form the gate. The stack structure of the polysilicon film and the metal film, however, has such problems as rapid dimension expansion, or an increase in the surface resistance, or related problems caused during etc. in a subsequent high temperature annealing process or the oxidization process. In particular, the most significant problem in the process is that lifting, ~~etc.~~ occurs since the metal film is oxidized in a given oxidization atmosphere. A new process that was developed in order to overcome this problem is the selective oxidization process. In other words, in ~~this~~ the selective oxidation process, the metal film is not oxidized but only the polysilicon film and the semiconductor substrate are oxidized, in a hydrogen (H₂) rich oxidization atmosphere. However, the current selective oxidization process has a ~~condition~~ problem in that it is possible when the tungsten film or the tungsten nitride film is used as the metal gate electrode. Further, as this oxidization process is possible in the H₂ rich atmosphere and at a very high temperature of 700°C, it may have influence on the characteristic of the MOSFET device.

SUMMARY OF THE INVENTION DISCLOSURE

Accordingly, ~~the present invention has been made~~ in view of the above problems, ~~and it is an object of the present invention to provide~~ a method of forming the gate in the semiconductor device is disclosed which is capable of stably improving the operational

characteristic by preventing oxidization at the interface of the polysilicon film and the metal film in the re-oxidization process.

~~Another object of the present invention is to provide a~~ A method of forming the gate in the semiconductor device is disclosed wherein the oxidization process implemented at low temperature can be applied even to the single gate of the metal film as well as the stack gate of the polysilicon film and the metal film, while preventing abnormal oxidization or the lift phenomenon from being generated.

In the case where the prior art re-oxidization process is performed using high temperature annealing at oxygen or H₂O atmosphere, oxygen that is diffused through the grain boundary and the bulk as well as the surface of the metal film due to very high temperature can oxidize the inside of the metal film and the interface of the polysilicon film and the metal film. For this reason, abnormal oxidization, lifting, and the like may occur. If the plasma oxidization process is performed at low temperature in lieu of high temperature annealing of the oxygen atmosphere, there is an advantage that only the surface of the stack gate of the polysilicon film and the metal film can be re-oxidized. Further, if high temperature annealing is implemented at nitrogen or hydrogen atmosphere after oxygen plasma treatment, the surface oxide film having much better characteristic can be obtained. Furthermore, this method can be applied irrespective of the type of the metal.

~~To achieve the above objects, according to the present invention, there is provide d~~
~~the~~ Therefore, a method of forming the gate in the semiconductor device is disclosed,
~~including the steps of~~ which comprises forming a gate pattern on which a gate oxide film and
a conductive layer are stacked at a give region on a semiconductor substrate, performing
oxygen plasma treatment to form oxide films at the sides of the conductive layer, and
performing an annealing process for improving the film quality of the oxide film.

BRIEF DESCRIPTION OF THE DRAWINGS

The above and other ~~objects~~, features and advantages of the ~~present invention~~
disclosed methods will be apparent from the following detailed description of the preferred
embodiments ~~of the invention~~ in conjunction with the accompanying drawings, ~~in which~~
wherein:

FIG. 1A ~~~through~~ FIG. 1C are cross-sectional views of semiconductor devices for
~~explaining~~ illustrating the disclosed methods of forming the a gate in the a semiconductor
device according to a ~~preferred embodiment of the present invention~~ this disclosure.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

Reference will now be made in detail to the at least one preferred embodiment of the
~~present invention~~, examples of which are illustrated in the accompanying drawings.

FIG. 1A ~~~~~ through FIG. 1C are cross-sectional views of semiconductor devices for
~~explaining~~ illustrating the disclosed methods ~~of forming the gate in the semiconductor device~~
~~according to a preferred embodiment of the present invention~~.

Page 5, lines 4-20:

In the above, the gate oxide film 12 is formed using a silicon oxide film such as SiO_2 , SiO_xN_y , etc. or high-dielectric metal oxide containing Hf or Zr such as HfO_2 , ZrO_2 , Hf-Al-O, Zr-Al-O, Hf-silicate, Zr-silicate, and the like. Further, the polysilicon film 13 is formed using a doped polysilicon film. Also, the anti-diffusion film 14 may be formed using WN_x , the stack film of W and WN_x , the stack gate of WSi_x and WN_x , TaSi_xN_y or TiAl_xN_y , wherein x and y have a value of $0.03 \sim 3.00$. Furthermore, the metal film 15 may be selectively formed using W, Ta, TaN, Ti or TiN. Meanwhile, it is preferred that the anti-diffusion film 14 and the metal film 15 are formed using the same series of materials in order to simplify the process. If the anti-diffusion film 14 is formed using WN_x , the stack film of W and WN_x or the stack film of WSi_x and WN_x , the metal film 15 is formed using W. If the anti-diffusion film 14 is formed using TaSi_xN_y , the metal film 15 is formed using Ta or TaN. If the anti-diffusion film 14 is formed using TiAl_xN_y , the metal film 15 is formed using Ti or TiN. Also, the anti-diffusion film 14 is formed in thickness of $10 \sim 300 \text{ \AA}$ and the metal film 15 is formed in thickness of $100 \sim 1000 \text{ \AA}$.

Page 6, line 15 to page 7, line 19:

If the oxygen plasma treatment ~~proposed by the present invention~~ disclosed here is performed, the edge of the gate oxide film and the surface of the gate are easily oxidized by oxygen radical that is activated by plasma at relative low temperature. As oxidization is not easily diffused since temperature is low, the inside of the gate is not oxidized. This has an advantage that oxidization at the interface of the polysilicon film and the metal film due to the high temperature re-oxidization process or selective oxidization can be prevented. Even

in case of the metal gate for which selective oxidization is impossible, the re-oxidization process is possible by using the above method. In another embodiment of the present invention, the gate may be formed using the anti-diffusion film and the metal film without forming the polysilicon film, and the oxidization process may be performed.

As described above, the ~~present invention has~~ disclosed techniques have a new effect that ~~it~~ they can accomplish a stable operational characteristic of the device by preventing oxidization at the interface of the polysilicon film and the metal film due to the high temperature re-oxidization process or the high temperature selective oxidization process since only the surface of the gate is oxidized. Further, the ~~present invention has~~ disclosed methods have an advantage that ~~it~~ they can be applied to the gate electrode of various metals since the re-oxidization process is possible by the present method even in case of the metal gate for which selective oxidization is impossible. Therefore, the present invention has a new effect that it can manufacture the single gate MOSFET of the metal film as well as the stack gate of the polysilicon film and the metal film.

The forgoing embodiments are merely exemplary and are not to be construed as limiting the present invention. The present teachings can be readily applied to other types of apparatuses. The description of the ~~present invention~~ disclosed methods is intended to be illustrative, and not to limit the scope of the claims. Many alternatives, modifications, and variations will be apparent to those skilled in the art.